Phoenix Controls Corporation

Designing a Green Lab without Sacrificing Safety

EXPERIENCE
A DRAMATICALLY
DIFFERENT VISION

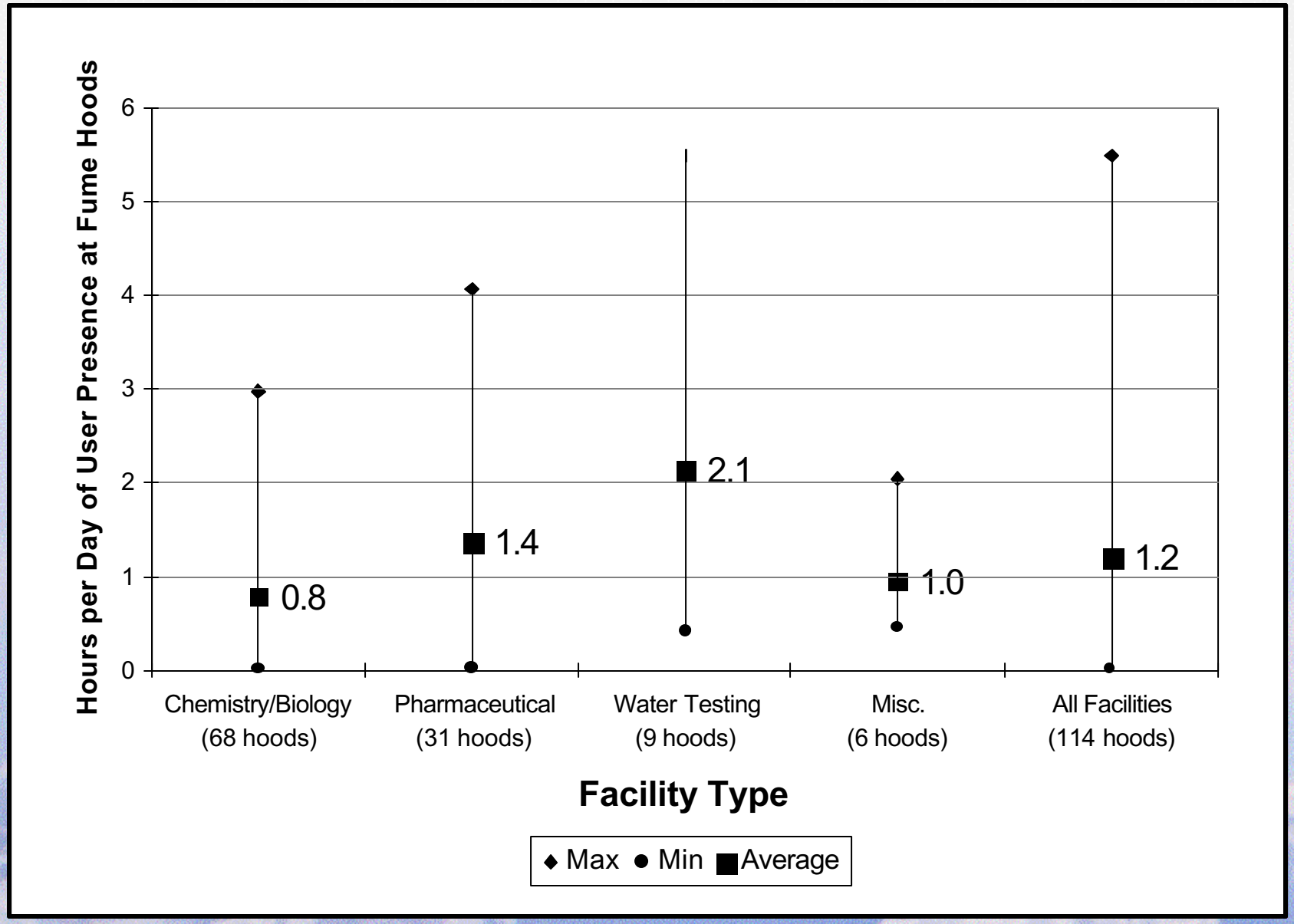
Laboratory Controls Objectives

- **Fume hood capture and containment**
- **Laboratory pressurization**
- **Minimum ventilation control**
- **Temperature control**

Laboratory Usage Patterns

- **24 hour operation**
- **100% outside air**
- **Typically 1 hour per day of fume hood**

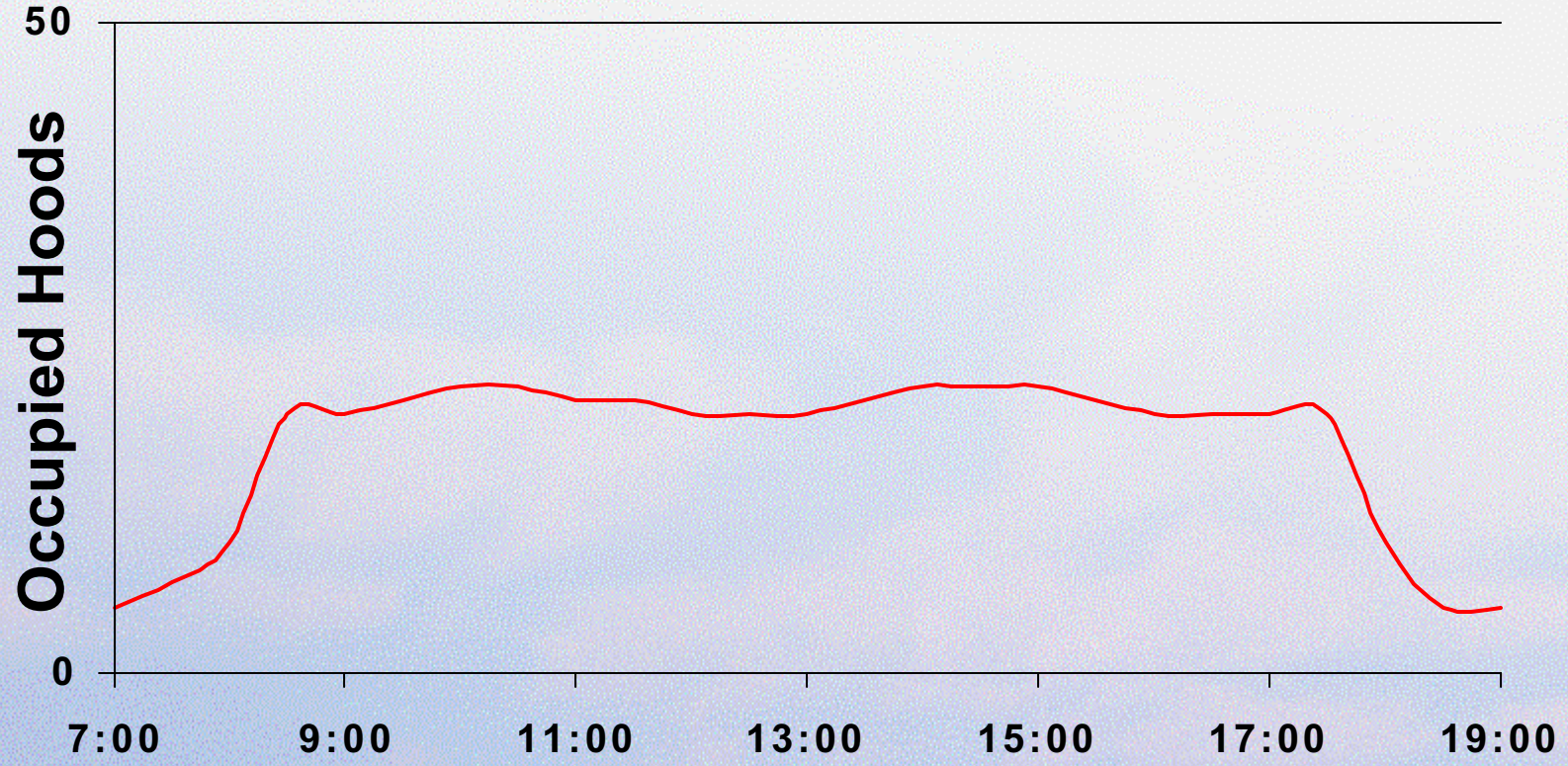
How Often are Hoods Used



Laboratory Usage Patterns

- 24 hour operation
- 100% outside air
- Typically 1 hour per day of fume hood
- **Occupancy in short segments**
- **Fume hood occupancy is independent**

Fume Cupboard Occupancy



Laboratory Usage Patterns

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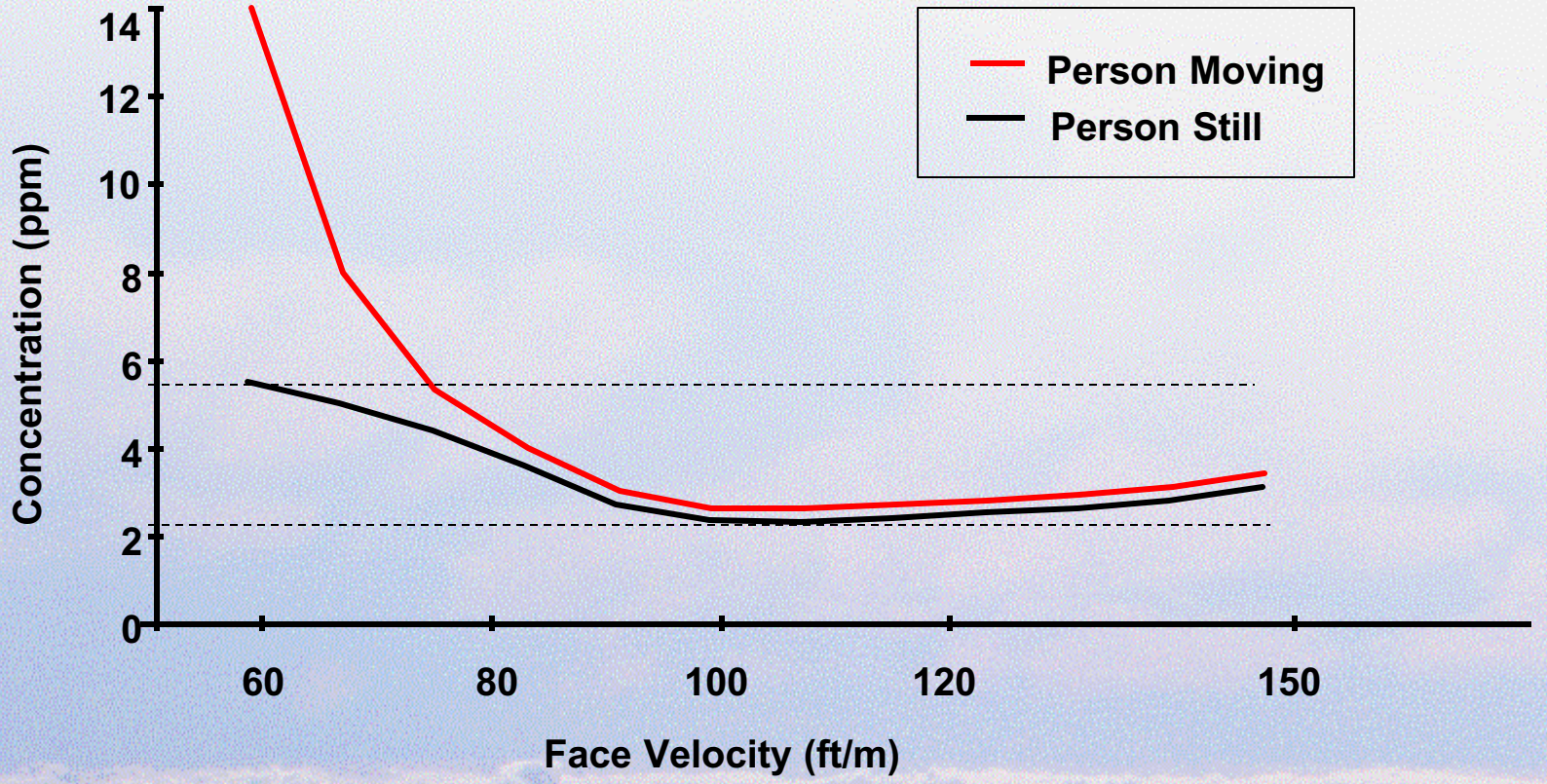
- Occupancy in short segments
- Fume hood occupancy is independent
- **Sash management varies widely**

Hood Leakage



What Is Diversity?

- **Diversity of operation**
- **Diversity types**
  - Phone company
  - Solar
  - Plumbing
  - Fume hood
- **Diversity factor definition**
  - 75% or 25%?

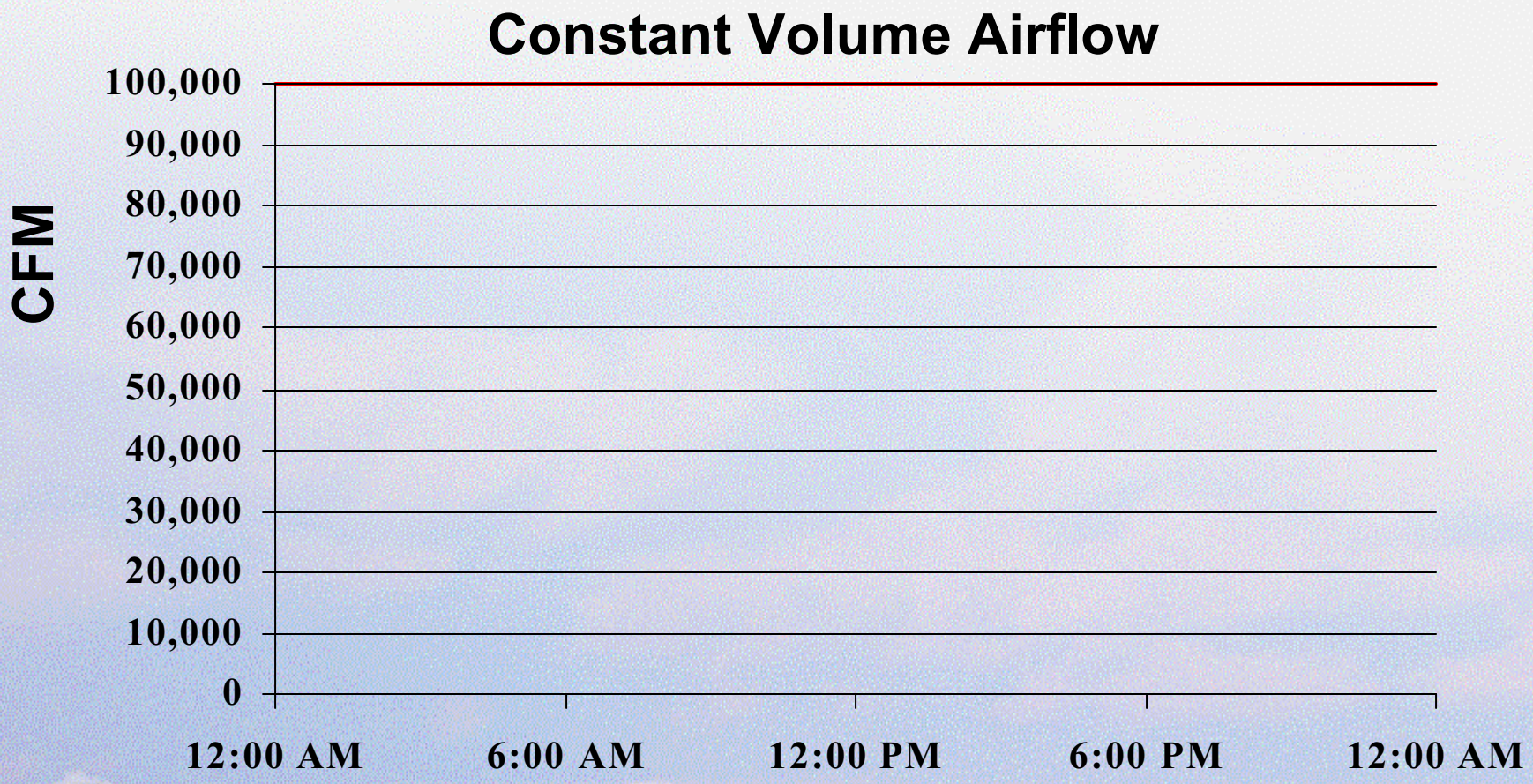
Factors Affecting Diversity

- **Control method**
- **Number of fume hoods per manifold**
- **Number of users per fume hood**
- **Fume hood usage type**
- **Cooling CFM requirements**
- **Minimum ventilation requirements**
- **Sash management**

A Diversity Example

- Chemistry research laboratory
- 100 fume hood manifold
- 1000 CFM maximum hood flow
- 5:1 fume hood turndown range
- 10 hour day
- 1 hour/day fume hood presence (10%)
- Present sash position is 100% open
- Absent sash position is 50% open

Constant Volume



A Little Math

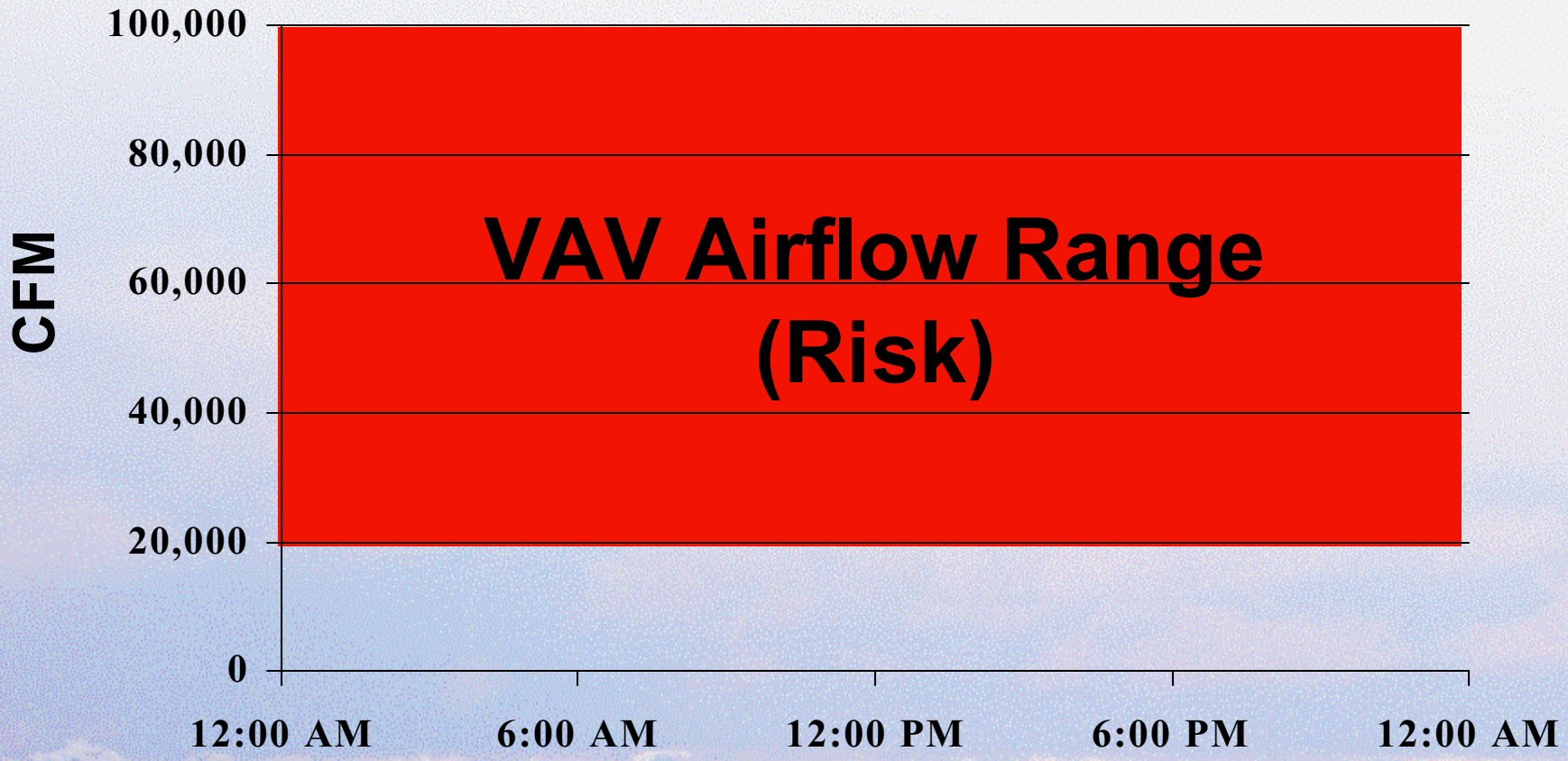
- **Fume hood occupancy is independent**
- **Binomial distribution as a tool**
- **Calculate fume hood diversity**
- **Number of fume hoods per manifold**
  - Hours per day at fume hood/total hours in day
  - Percent design criteria
  - Sash positions

Example With VAV Control

18 Occupied	X 1000 CFM	18,000 CFM
82 Unoccupied	X 500 CFM	41,000 CFM
99% Design Airflow		59,000 CFM

99% of the time, airflow for this system will be at 59,000 CFM or less, *if people close their sashes to the 50% level.*

VAV Design Uncertainty



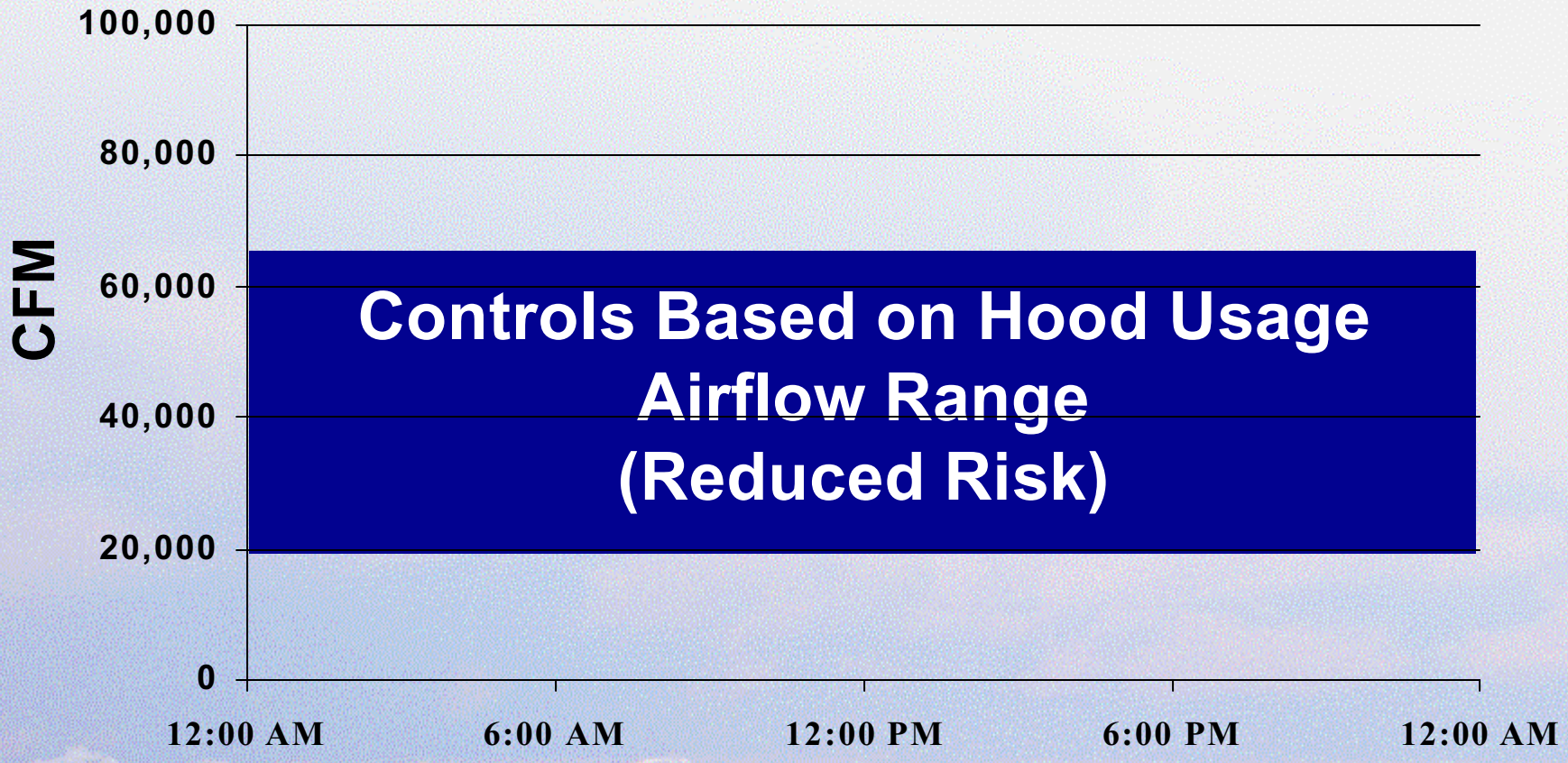
Example With Controls Based on Hood Usage

18 Occupied	**X 1000 CFM**	**18,000 CFM**
82 Unoccupied	**X 300 CFM**	**24,600 CFM**

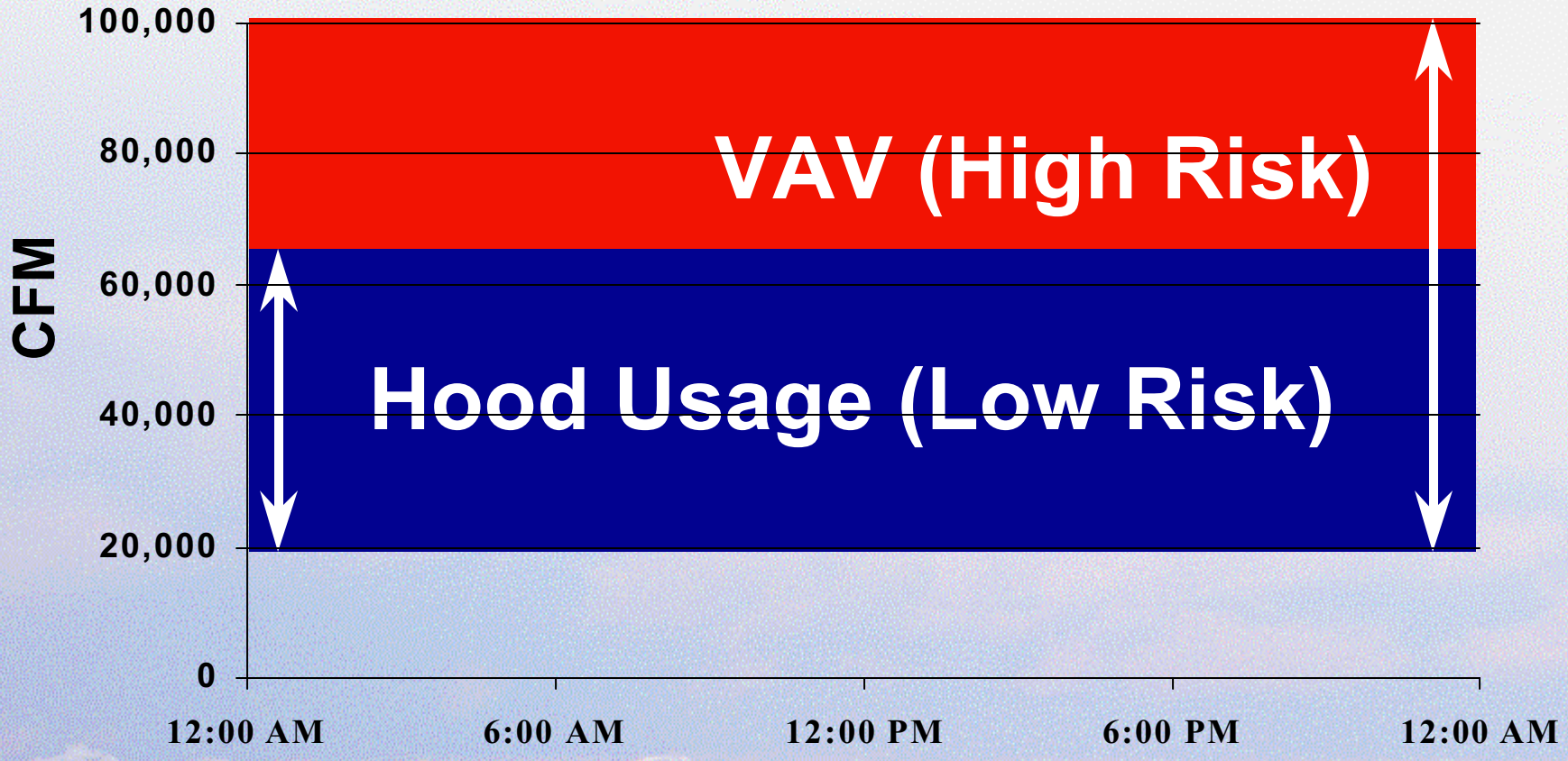
99% Design Airflow **42,600 CFM**

99% of the time, airflow for this system will be at 42,600 cfm or less, *if people close their sashes to the 50% level; 67,200 cfm or less if they leave sashes wide open.*

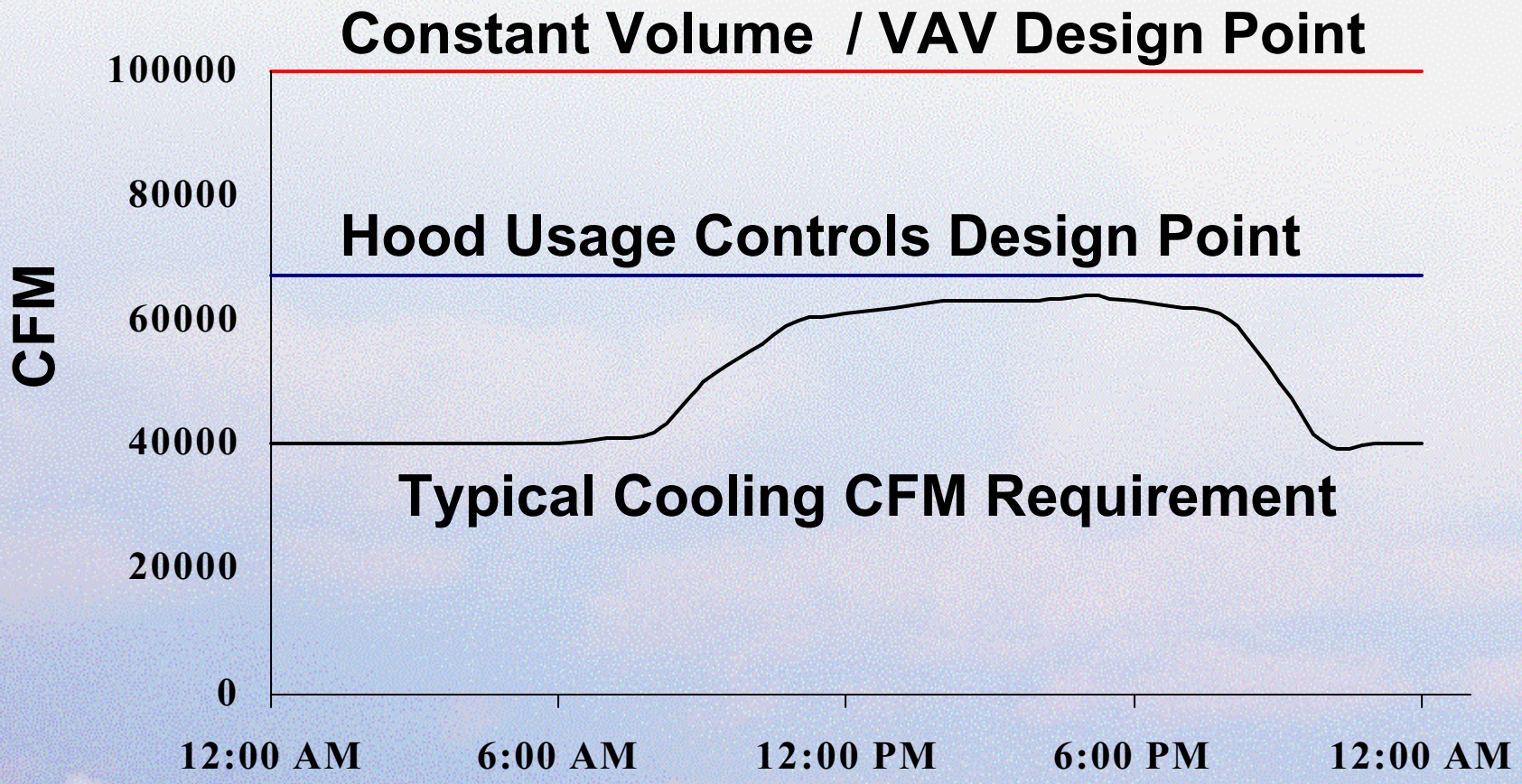
Controls Based on Hood Usage



Reducing Design Risk



Typical Airflows Comparison



Capital Savings Opportunities

- **Cooling systems**
- **Heating systems**
- **Reheat systems**
- **Supply and exhaust fans**
- **VFDs**
- **Ductwork and piping**
- **Other**

Controls Based Hood Usage Average Flow

10 Occupied	**X 1000 cfm**	**10,000 cfm**
90 Unoccupied	**X 300 cfm**	**27,000 cfm**

Average Airflow **37,000 cfm**

Average airflow for this system will be 37,000 cfm, *if people close their sashes to the 50% level;* 64,000 cfm *if they leave sashes wide open.*

Expected Energy Savings Vs. Constant Volume

Control	Savings
Constant Volume	0%
VAV	0 - 65%
Hood Usage	30 - 80%

*Life Cycle Cost Comparison**

System	1 Year	5 Years	10 Years
CV	$1,700,000	$2,900,000	$4,400,000
VAV	$1,815,000	$2,475,000	$3,300,000
Usage	$1,161,000	$1,605,000	$2,160,000
Savings	$539,000	$1,295,000	$2,240,000

*Includes mechanical system first cost & and energy costs

Case Studies

- **Textile research facility (retrofit)**
- **Small southern university (retrofit)**
- **Western university (new)**

Textile Research Facility

- **26 existing fume hoods**
- **Wanted 26 more**
- **Options: replace mechanical system or construct a new building, or...**
- **Use diversity**
  - Doubled the hood count with the existing mechanical system
  - Saved time, money, and energy

Small Southern University

- **Many existing problems**
- **Wanted more fume hoods**
- **Initial costs estimates too high, so...**
- **Used diversity**
  - Added 20 new fume hoods without additional mechanical systems
  - Cured existing problems and saves energy
  - Cost 70% less than original estimates

Large Western University

- **New chemistry building (190,000 ft^2)**
- **193 fume hoods (189,000 cfm)**
- **Diversity**
  - Extra mechanical system capacity
  - 53,000 cfm max hood exhaust flow
  - Major energy savings
  - 8 months payback

Thank You

Questions